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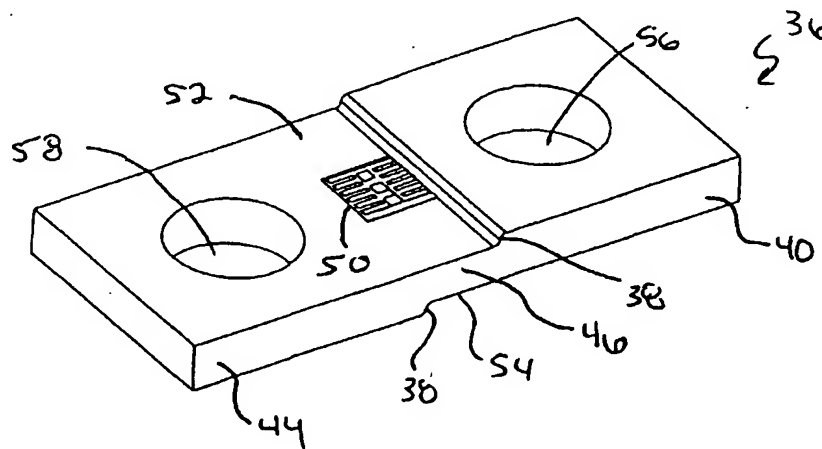
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- (51) International Patent Classification?: B60R 21/01, G01G 19/414 (72) Inventor: CURTIS, Brian, M.; 3285 Regency Drive, Lake Orion, MI 48359 (US).
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- (71) Applicant: SIEMENS AUTOMOTIVE CORPORATION [US/US]; 2400 Executive Hills Drive, Auburn Hills, MI 48326 (US). For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: WEIGHT SENSOR ASSEMBLY FOR DETERMINING SEAT OCCUPANT WEIGHT



(57) Abstract: A system for measuring the weight of a seat occupant is used to control airbag deployment. The system includes a plurality of weight sensors that have a first end mounted to a seat riser and a second end mounted to a seat frame or track member. The weight sensors have a central bendable portion that extends between the first and second ends. A groove is formed in one of the external surfaces of the central bendable portion to localise strain. A full bridge strain gage assembly is mounted on a surface of each of the weight sensors, opposite from the groove, for generating a weight signal in response to measuring deflection of the central bendable portion. A central processor determines seat occupant weight based on the weight signals and an airbag control module communicates with the processor. The control module controls deployment force of the airbag based on seat occupant weight.



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WEIGHT SENSOR ASSEMBLY FOR DETERMINING SEAT OCCUPANT WEIGHT

BACKGROUND OF THE INVENTION

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1. Field of the Invention.

This invention relates to an apparatus for measuring the weight of a seat occupant. Specifically, a sensor arrangement is mounted to a seat frame member to provide seat occupant weight measurements.

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2. Related Art.

Most vehicles include airbags and seatbelt restraint systems that work together to protect the driver and passengers from experiencing serious injuries due to a high speed collision. It is important to control the deployment force of the airbags and the force of the seatbelt pre-tensioners based on the size of the driver or the passenger.

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One way to control these forces is to monitor the weight of the seat occupant. If a smaller person such as a child or infant in a car seat is in the front passenger seat, the weight on the seat will be less than if an adult occupies the seat.

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Current systems for measuring the weight of a seat occupant are complex and expensive. One type of system uses pressure sensitive foil mats mounted within the seat bottom foam. Another system uses sensors placed at a plurality of locations within the seat bottom cushion. The combined output from the mats or the sensors is used to determine the weight of the seat occupant. These sensors experience a substantially vertical force, due to the weight of the seat occupant, but are also subject to longitudinal and lateral forces caused by acceleration, deceleration, or turning. The lateral and longitudinal forces picked up by the sensor incorporate an error component into the weight measurement. The sensors are very sophisticated using multiple strain gages and complicated bending elements to provide high measurement sensitivity in the vertical direction and low sensitivity to lateral and longitudinal forces in order to increase accuracy.

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Mounting these sensors within the seat bottom can also be difficult and time consuming. It is difficult to find mounting locations for each the sensors that will

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accommodate all of the various positions of a seated occupant while still providing accurate measurements. Further, shifting of the occupant on the seat can dislodge or move the sensors out of their proper location. Because the sensors are mounted within the seat bottom, it is difficult to reposition the sensors after the seat is installed in the vehicle.

Thus, it is desirable to have a simplified seat occupant weight measurement system that is accurate and easily to install and overcomes the above references deficiencies with prior art systems.

SUMMARY OF THE INVENTION

In a disclosed embodiment of this invention, a system for measuring the weight of an occupant seated on a vehicle seat includes a seat element mounted to a vehicle structure and a seat support member for supporting a seat bottom. A plurality of weight sensor assemblies are mounted between the seat element and the seat support member. Each of the weight sensor assemblies has a bottom surface and a top surface with a full bridge strain gage mounted on one of the surfaces.

In a preferred embodiment, each weight sensor assembly has a first end mounted to the seat element, such as a seat riser, and a second end mounted to the seat support member, such as a seat frame or track member, with a central bendable portion extending between the first and second ends. The strain gages each generate a weight signal in response to measuring deflection of the central bendable portion for the respective sensor assembly. A central processor determines the seat occupant weight based on the weight signals. An airbag control module communicates with the processor to control deployment force of an airbag based on seat occupant weight.

In a further preferred embodiment, each of the sensors includes at least one groove formed in one of the top or bottom surfaces. The groove extends at least partially along the width of the sensor to localize strain in the central bendable portion. The strain gage is placed on the other of the top or bottom surfaces, facing opposite from the groove.

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The subject invention provides a simplified seat occupant weight measurement system that is inexpensive, accurate, and easily to install. These and other features of the present invention can be best understood from the following specification and drawings, the following of which is a brief description.

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BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 is an environmental view of a seat occupant seated in a vehicle having an airbag system.

Figure 2 is an exploded view of a seat assembly incorporating the subject weight measurement system.

Figure 3 is a side view, partially cut-away, of the seat of Figure 2 showing the mounting of one sensor assembly.

Figure 4 is a perspective view of the sensor assembly of Figure 3.

Figure 5 is a schematic diagram of the control system incorporating the subject weight measurement system.

Figure 6A is a top perspective view of a preferred embodiment of a sensor assembly.

Figure 6B is a bottom perspective view of the sensor assembly of Figure 6A.

Figure 6C is a cross-section view of the sensor assembly taken along 6C-6C of Figure 6A.

Figure 7 is an alternate embodiment of a weight sensor.

Figure 8 is an alternate embodiment of a weight sensor.

DETAILED DESCRIPTION OF AN EXEMPLARY EMBODIMENT

A vehicle includes a vehicle seat assembly, shown generally at 12 in Figure 1, and an airbag system 14. The seat assembly 12 can be either a driver or passenger seat and includes a seat back 16 and a seat bottom 18. When a vehicle occupant 20 is seated on the seat 12 a vertical force F_v is exerted against the seat bottom 18. The vertical force F_v represents the weight of the seat occupant 20.

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The airbag system 14 deploys an airbag 24 under certain collision conditions. The deployment force for the airbag 24, shown in dashed lines in Figure 1, varies according to the weight of the occupant 20. The vehicle includes a unique system for measuring the weight of the seat occupant 20. This unique system is integrated into a seat frame or track member, generally indicated at 26 in Figure 2.

The seat 12 is preferably mounted to a vehicle structure 30 on an inboard track assembly 26a and an outboard track assembly 26b that is spaced apart from the inboard track assembly 26a by a predetermined distance. Both the inboard 26a and outboard 26b track assemblies include first 28 and second 32 track members. The first track member 28 is typically mounted to a seat riser 34 or directly to the vehicle structure 30, such as a floor. The second track member 32 is mounted for sliding movement relative to the first track member 28 so that seat 12 position can be adjusted forwardly and rearwardly within the vehicle to a desired position.

A plurality of sensor assemblies 36 are mounted between the first track members 28 of the inboard 26a and outboard 26b track assemblies and the riser 34. In the preferred embodiment, four (4) sensor assemblies 36 are used with a first sensor assembly 36a positioned near the front of the inboard track assembly 26a, a second sensor assembly 36b positioned near the rear of the inboard track assembly 26a, a third sensor assembly 36c positioned near the front of the outboard track assembly 26b, and a fourth sensor assembly 36d positioned near the rear of the outboard track assembly 26b.

Preferably, each sensor assembly 36a, 36b, 36c, and 36d has a first end 40 mounted to the first track member 28 with at least one fastener 42 and a second end 44 mounted to the riser 34 with at least one fastener 42, as shown in Figure 3. It should be understood that any type of fastener can be used and that other joining methods known in the art can also be used to mount the sensors 36. A central bendable portion 46 extends between the first 40 and second 44 ends of the sensor assembly 36. As the vertical force F_v of the seat occupant 20 is exerted on the seat bottom 18, the central bendable portion 46 of each sensor assembly 36a, 36b, 36c,

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36d deflects or bends into an S-shaped configuration putting one portion of the sensor 36 in compression and another portion in tension.

5 In the embodiment of Figures 3 and 4, the first 40 and second 44 ends are raised above/below the central bendable portion 46 to form steps 38 on each side of the central bendable portion 46. The height of the steps 38 can be varied. This configuration forms gaps between the sensor 36 and the track member 28 and between the sensor 36 and the riser 34 to facilitate bending.

10 A strain gage 50 is mounted to each of the sensors 36a, 36b, 36c, 36d to measure the amount of bending in the central portion 46. The sensors 36 have a top surface 52 facing the seat bottom 18 and a bottom surface 54 facing the riser 34. Preferably, a combination of four (4) strain gages, forming a full bridge, are mounted on one of the top 52 or bottom 54 surfaces to measure the bending. The four strain gages are thus combined to serve as a Wheatstone Bridge for measuring deflection. The operation of a Wheatstone Bridge is well known in the art.

15 As shown in Figure 4, the stain gage 50 is mounted on the top surface 52 of the sensor 36. A first aperture 56 is formed at the first end 40 of the sensor 36 and a second aperture 58 is formed at the second end 44 of the sensor 36 for receiving the fasteners 42. The strain gage 50 is positioned between the apertures 56, 58 on the top surface 52. In order to achieve more accurate readings, full-bridge strain gage 50 should have all strain gage components mounted on only one surface of the sensor 36. In other words, if the strain gage 50 is mounted on the top surface 52 then no strain gage components should be mounted on the bottom surface 54 or if the gage 50 is mounted on the bottom surface 54 then no strain gage components should be mounted on the top surface 52.

25 The sensors 36a, 36b, 36c, 36d each generate a signal representative of the occupant weight that causes bending at the respective location of the sensors 36a, 36b, 36c, 36d, see Figure 5. Thus, the first sensor 36a generates a first signal 60, the second sensor 36b generates a second signal 62, the third sensor 36c generates a third signal 64, and the fourth sensor 36d generates a fourth signal 66. The signals 30 60, 62, 64, 66 are transmitted to a common interface unit 68 and are then fed into a

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central processor unit or electronic control unit (ECU) 70 as is known in the art. The ECU 70 combines the signals 60, 62, 64, 66 to determine the weight of the occupant 20. The ECU 70 then sends a control signal 72 to a system controller 74. Preferably, the system controller 74 is an airbag control module that is in communication with the ECU 70 such that the deployment force of the airbag 24 is controlled based on seat occupant weight. The system controller 70 could also be used to control the force of seat belt pretensioners based on occupant weight. A vehicle crash sensor 76 also supplies information to the airbag control module 74 that is used in preparation for the control instructions for the airbag 24. The system utilizes a power supply 78 as is known in the art.

A preferred embodiment of a weight sensor 136 is shown in Figures 6A-6C. In this preferred embodiment each of the sensor assemblies 136a, 136b, 136c, 136d includes at least one groove 80 formed in one of the top 52 or bottom 54 surfaces of the sensor 36. The groove 80 extends at least partially along the width of the sensor assembly 36 to localize strain in the central bendable portion 46. The full bridge strain gage 50 is placed the opposing surface, facing an opposite direction from the groove 80; see Figure 6B. In this embodiment, the groove 80 extends across the entire width of the sensor 36.

In an alternate embodiment of a weight sensor 236, shown in Figure 7, a pair of grooves 80a, 80b are formed in one of the top 52 or bottom 54 surfaces to localize strain in the central bendable portion 46. The grooves 80a, 80b are spaced apart from one another and only extend partially across the width of the sensor 36. In this embodiment, the strain gage 50 is mounted between the grooves 80a, 80b.

In another alternate embodiment of a weight sensor 336, shown in Figure 8, the sensor assembly 36 has a generally flat central bendable portion 46. A notch 84 is formed at one end that separates a pair of holes 86 that are used to connect the sensor 36 to the interface 68.

The subject invention offers a simplified system for measuring the weight of a seat occupant 20. It is preferable to integrate the sensors 36 between the track 28 and the riser 34 because they are common components for most vehicle seats 12.

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The subject weight measurement system is easily incorporated into any type of seat configuration. The measured weight is independent of seat position and is accurately provided in various occupant positions on the seat 12.

5 By measuring the deflection in all four (4) locations in the inboard 26a and outboard 26b track assemblies, it is possible to calculate the occupant weight, which is proportional to the sum of the output of all of the sensors 36a, 36b, 36c, 36d. The electronics for signal conditioning and the interface 68 can be housed within the track assemblies 26a, 26b as is well known in the art.

10 Although a preferred embodiment of this invention has been disclosed, it should be understood that a worker of ordinary skill in the art would recognize many modifications come within the scope of this invention. For that reason, the following claims should be studied to determine the true scope and content of this invention.

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CLAIMS

I claim:

1. A system for measuring the weight of an occupant seated on a vehicle
5 seat comprising:
a seat element mounted to a vehicle structure;
a seat support member for supporting a seat bottom; and
a plurality of weight sensor assemblies mounted between said seat element
and said seat support member, each of said weight sensor assemblies having a
10 bottom surface and a top surface with a full bridge strain gage mounted on one of
said surfaces.
2. A system according to claim 1 wherein said full bridge strain gage is
15 mounted to said bottom surface.
3. A system according to claim 1 wherein said seat element includes a
seat riser that is mounted to a vehicle floor.
4. A system according to claim 3 wherein said seat support member is a
20 seat track member fixed to said riser.
5. A system according to claim 4 wherein each of said sensor assemblies
has a first end fixed to said seat track and a second end fixed to said riser with a
central bendable portion extending between said first and second ends.
25
6. A system according to claim 5 wherein said full bridge strain gage is
mounted on said central bendable portion.
7. A system according to claim 1 wherein each of said sensor assemblies
30 includes a central bendable portion with at least one groove formed in one of said

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top or bottom surfaces and extending at least partially along the width of said sensor assembly to localize strain in said central bendable portion.

8. A system according to claim 7 wherein said full bridge strain gage is placed on the other of said top or bottom surfaces, facing opposite from said groove.

9. A system according to claim 1 wherein each of said sensor assemblies generates a weight signal representing a portion of the weight of a seat occupant that is transmitted to a central processing unit to determine seat occupant weight.

10. A system according to claim 9 including an airbag control module in communication with said processor wherein deployment force of an airbag is controlled by said control module based on seat occupant weight.

11. A system for measuring the weight of an occupant seated on a vehicle seat comprising:

a seat riser mounted to a vehicle structure;

a seat frame member for supporting a seat bottom;

a plurality of weight sensors each having a first end mounted to said seat riser and a second end mounted to said seat frame with a central bendable portion extending between said first and second ends;

a strain gage assembly mounted only on either a top or bottom surface of each of said weight sensors for generating a weight signal in response to measuring deflection of said central bendable portion;

a central processor for determining seat occupant weight based on said weight signals; and

an airbag control module in communication with said processor wherein deployment force of an airbag is controlled by said control module based on seat occupant weight.

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12. A system according to claim 11 wherein each of said sensors includes at least one groove formed in one of said top or bottom surfaces and extending at least partially along the width of said sensor to localize strain in said central bendable portion.

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13. A system according to claim 12 wherein said strain gage assembly is placed on the other of said top or bottom surfaces, facing opposite from said groove.

14. A system according to claim 13 wherein said each of said strain gage assemblies is a full bridge gage.

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15. A system according to claim 14 wherein each of said full bridge gages are mounted on said bottom surface of said sensors.

16. A system for measuring the weight of an occupant seated on a vehicle seat comprising:

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a seat bottom;

an inboard track assembly and an outboard track assembly spaced apart from each other and mounted to the vehicle structure, said inboard and outboard track assemblies each having a first track mounted to a seat riser and a second track mounted for movement relative to said first track;

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a first weight sensor positioned near a forward portion of said inboard track assembly;

a second weight sensor positioned near a rearward portion of said inboard track assembly;

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a third weight sensor positioned near a forward portion of said outboard track assembly;

a fourth weight sensor positioned near a rearward portion of said outboard track assembly;

-11-

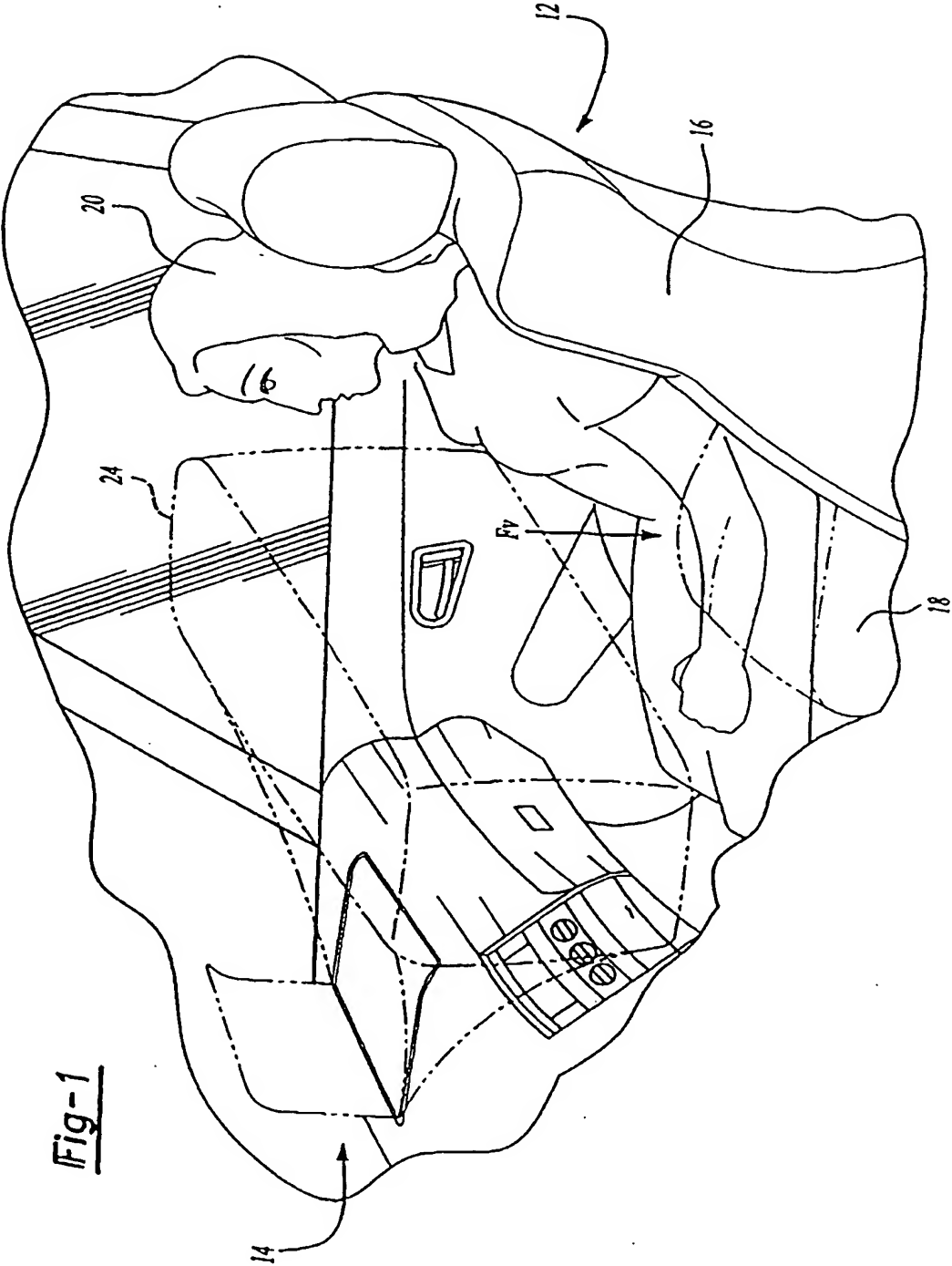
each of said weight sensors having a first end fixed to said first track and a second end fixed to said riser with a central bendable portion extending between said first and second ends;

5 at least one groove formed in one of a top or bottom surface of each of said sensors and extending at least partially along the width of said sensor to localize strain in said central bendable portion;

a full bridge strain gage assembly mounted on the other of said top or bottom surfaces of each of said sensors, facing away from said groove, said gage assemblies each generating a weight signal in response to measuring deflection of said central
10 bendable portion of said respective sensor;

a central processor for determining seat occupant weight based on said weight signals; and

an airbag control module in communication with said processor wherein deployment force of an airbag is controlled by said control module based on seat
15 occupant weight.



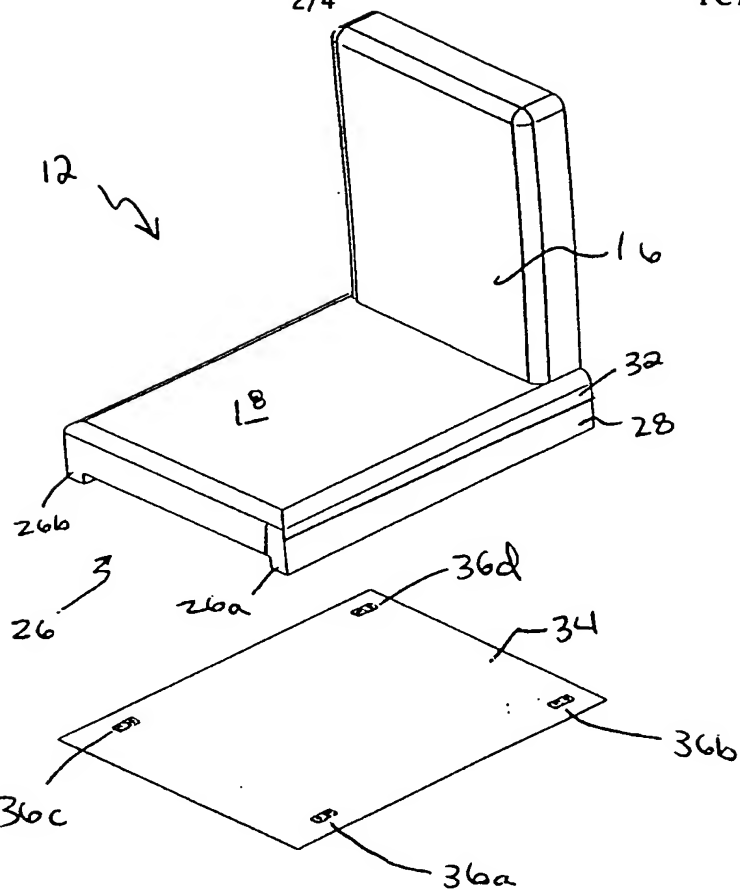


Fig. 2

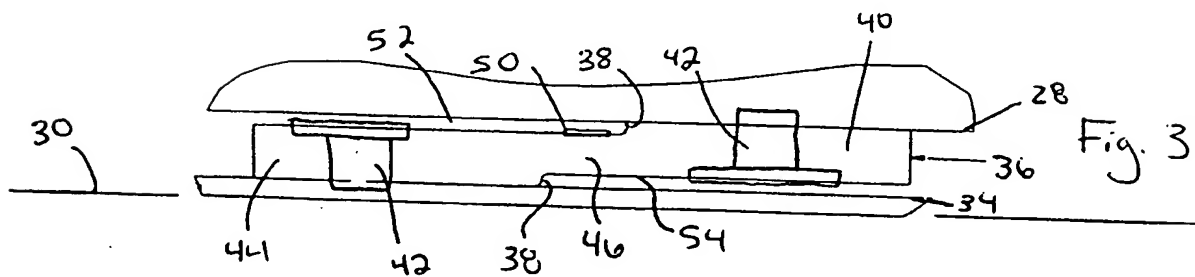


Fig. 3

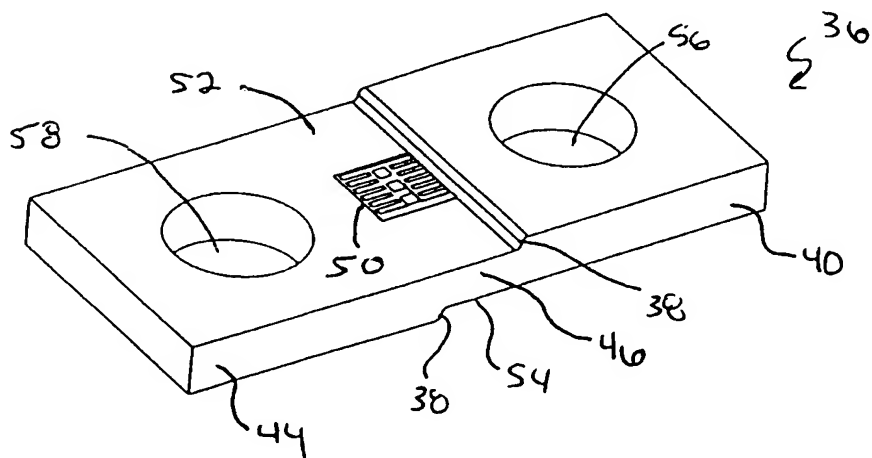


Fig. 4

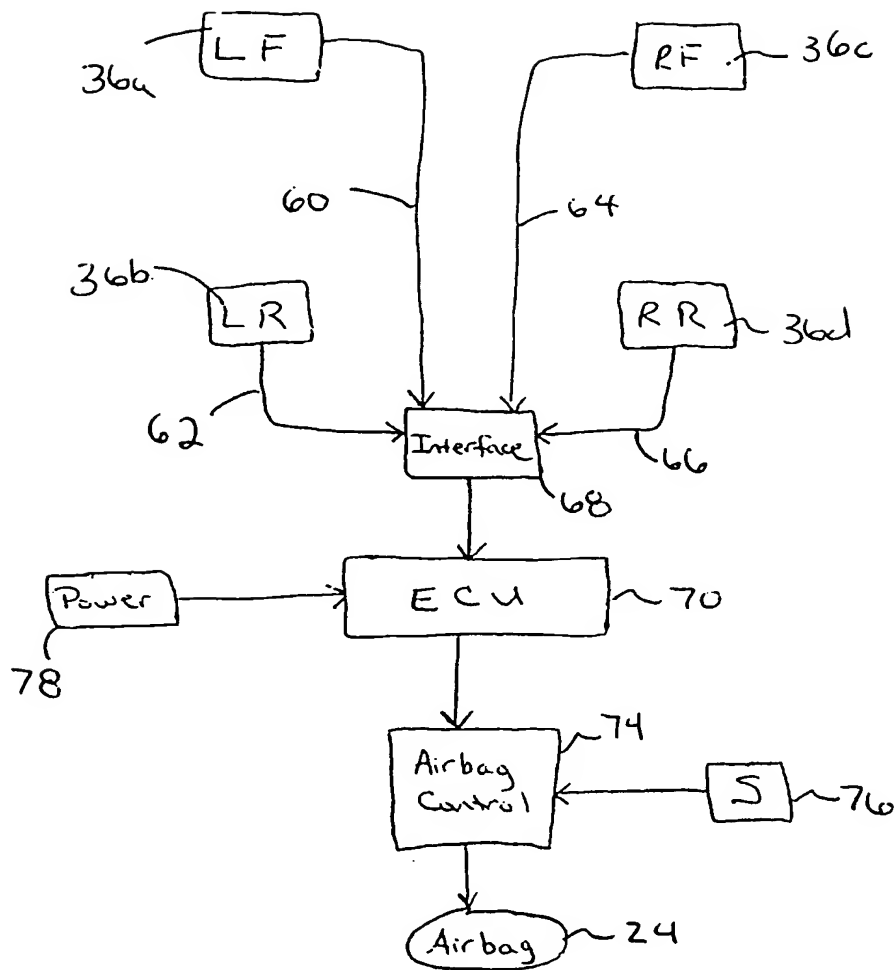
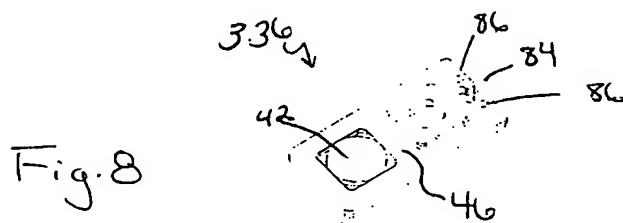
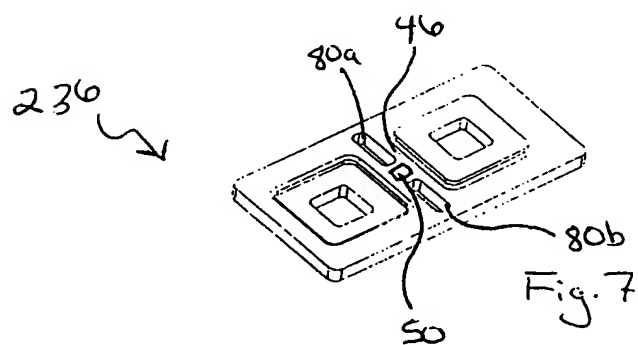
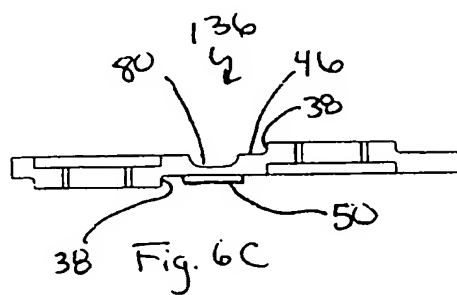
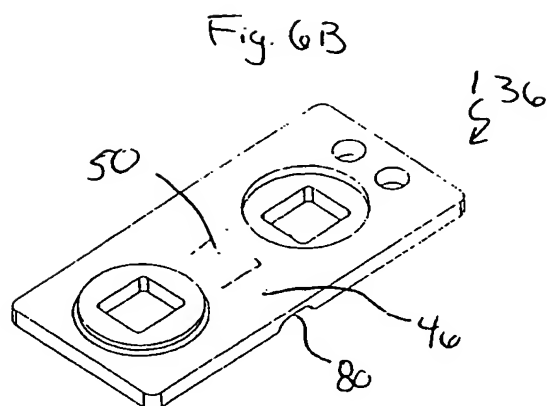
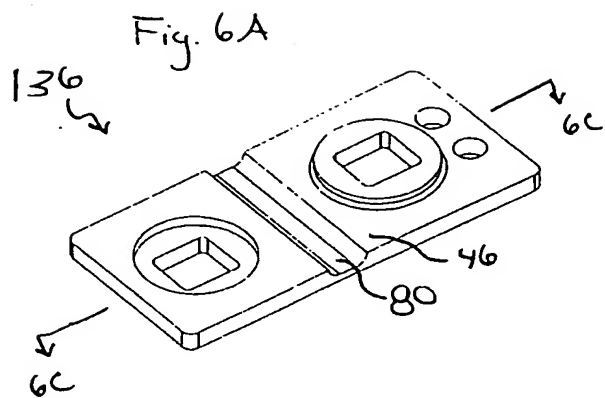


Fig. 5



INTERNATIONAL SEARCH REPORT

International Application No.

PCT/US 00/17237

A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 B60R21/01 G01G19/414

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B60R G01G G01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	US 6 039 344 A (FULLERTON MICHAEL G ET AL) 21 March 2000 (2000-03-21) column 2, line 21 - line 30 column 3, line 1 - line 65 figures 1-5	1-6,8,9, 11
A	"WEIGHT SENSING FOR OCCUPANT RESTRAINT UTILIZING LOAD CELL TECHNOLOGIES" RESEARCH DISCLOSURE, GB, INDUSTRIAL OPPORTUNITIES LTD. HAVANT, no. 399, 1 July 1997 (1997-07-01), page 442 XP000726567 ISSN: 0374-4353 the whole document	1-16

☐ Further documents are listed in the continuation of box C.☒ Patent family members are listed in annex.

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Date of the actual completion of the international search

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/US 00/17237

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 6039344 A	21-03-2000	NONE	